Pertanika J. Sci. & Technol. 25 (S): 147 - 156 (2017)

SCIENCE & TECHNOLOGY

Journal homepage: http://www.pertanika.upm.edu.my/

# Chemical Characteristics and Sensory Properties of Biscuits using Modified Potato Flour

**Mustika Nuramalia Handayani* and Dewi Cakrawati**

*Study Program of Agro-industry Technology Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229 Bandung 40154 Jawa Barat – Indonesia*

## ABSTRACT

Consumer demand for composite flour-based biscuit has increased. 'Healthy biscuits' containing fibre as functional food has become a trend. This study examined the properties of biscuits made from modified potato flour. Resistant starch in modified potato flour may serve as dietary fibre and hence, the purpose of this study was to determine the chemical characteristics and sensory properties of these biscuits. Therefore, the modified potato flour was subjected to two different treatments in order to examine its properties: a) three heat treatment: boiling, steaming, and baking, b) substituting it at10, 20, 30, and 40% levels respectively. Results showed that biscuit substituted with modified potato flour was acceptable to consumers based on sensory assessment. Different heat treatment did not have an effect on biscuit taste. Biscuits made from 40% modified potato flour contains a good source of 6.49% dietary fibre, and fat, protein, ash and moisture contents of 28.5%, 9.90%, 0.02%, and 4.04% respectively.

*Keywords:* Biscuit, chemical characteristics, modified potato flour, sensory properties

## INTRODUCTION

Biscuits are usually considered unhealthy due to their high fat and high sugar content. However, traditional biscuits can be healthier source of food if they are made from modified potato flour to have fewer calories and extra nutrients with superior quality and flavour (Boobier, Baker, & Davies, 2006). This is considered functional food which can be natural, where a component has been added or where the nature of one or more food components have been modified, or any combination of these (Gibson & Williams, 2000).

Consumer demand for composite flour-based biscuit has increased. Table 1 lists the studies that focused on the properties of biscuits made from modified and combination

ARTICLE INFO

*Article history:*
Received: 12 January 2017
Accepted: 02 October 2017

*E-mail addresses:*
mustika@upi.edu (Mustika Nuramalia Handayani),
dewicakrawati@upi.edu (Dewi Cakrawati)
*Corresponding Author

ISSN: 0128-7680 

of different flour. Biscuits made from blends of cowpea flour and wheat flour was acceptable to consumers as they had increased protein content (Akubor, 2003). The incorporation of buckwheat in composite flour has beneficial nutraceutical properties and its gluten-free nature has a role in preventing celiac problem (Baljeet, Ritika, & Roshan, 2010). Biscuits that contain mango peels and kernel powder are more nutritional and have antioxidant properties (Ashoush & Gadallah, 2011). Cookies made from legume flour have high protein content as well as resistant starch (Aziah & Noor, 2012). Biscuits made from oat flour, finger millet flour, pigeon pea flour and green gram flour with wheat flour meet the protein needs of humans (Serrem, de Kock, & Taylor, 2011)

Table 1
*Current reports on biscuit modifications*

| Materials and method | Results | References |
|---|---|---|
| Using 30% cowpea flour to substitute plantain flour | The Cow Pea Plantain Flour (CPF) biscuit acceptable to consumers based on the -+flavour, texture, and overall acceptability. High protein content with increased CPF in the blend. | (Akubor, 2003) |
| Using buckwheat flour to make biscuits | Biscuits made from 20% and 30% buckwheat flour acceptable to consumers. | (Baljeet et al., 2010) |
| Using mango peel powder (MPP) and mango kernel powder (MKP) to make biscuits | The antioxidant properties of biscuit made from MPP and MKP increased. Mango-flavoured biscuits were good source of nutrient using to 10% MPP and up to 40% MKP | (Ashoush & Gadallah, 2011) |
| Substituting wheat flour with legume flour (mung bean and chick pea) in cookies. | Chickpea cookies made of 50% wheat flour + 35% chickpea flour + 15% corn flour had the best flavour, crispiness and acceptability and high protein and resistant starch content. | (Aziah & Noor, 2012) |
| Mixing oat flour, finger millet flour, pigeon pea flour and green gram flour with wheat flour in different proportions (i.e. 0%, 10%, 25% and 50%) along with fenugreek leaf/ fenugreek powder to make biscuits | Biscuit acceptable to consumers and meet the needs of protein | Serrem, de Kock, & Taylor, 2011) |

Gluten-free biscuit with high-fibre has become an industry wide trend (Hosafci, 2016). Resistant starch (RS) may serve as dietary fibre and deliver a positive impact on health. However, further studies into its beneficial effects are crucial (Leszczynski, 2004). The RS has low impact on the sensory properties due to its swelling capacity, viscosity, gel formation and water-binding capacity which makes it popular in a variety of foods (Ashraf, Anjum, Nadeem, & Riaz, 2012). In general, tubers and legumes have more RS than cereals. Among the selected foods, potato showed the highest amount of RS (Chen, Liu, Qin, Mph, & Zhang, 2010). Heat-cold treatment in potato starch can result in changes in type of RS. The RS in potato was originally type 2 (ungelatinised resistant granules) transformed into type 3 (retrograded starch) which is more

resistant to digestive enzyme, so, it acts as a prebiotic (Sajilata, Singhal, & Kulkarni, 2006; Wulan, Saparianti, Widjanarko, & Kurnaeni, 2006). Therefore, heat-cold treatment can be applied to modified potato flour used in manufacturing composite flour-biscuit.

The purpose of this study was to examine chemical characteristics and sensory properties of biscuit made from wheat flour substitute, namely modified potato flour. During the experiment, potato flour was modified physically via heat treatment (boiling, steaming, and baking) and cooled. The modified potato flour was added as substitute to wheat flour and results showed that consumers liked the biscuit which had higher dietary fibre content compared with traditional biscuits. In addition, since the product was made from composite flour (modified potato flour and wheat flour), future study can examine positive health impacts of reduction in wheat flour consumption (containing gluten) and the product can be a potentially healthy biscuit and a good source of dietary fibre.

## MATERIALS AND METHODS

Materials used in this research were potato tubers obtained from a local farmer (Pangalengan, Indonesia). Wheat flour, full cream milk, refined sugar (100% sucrose) and butter were procured from local market in Bandung. Potato flour was modified physically. The research was conducted in several stages: (1) manufacture of physically modified potato flour, (2) analysis of characteristics of physically modified potato flour characteristics; (3) manufacture of biscuit made from wheat flour substitute i.e. physically modified potato flour; (4) analysis of chemical characteristics and sensory properties of biscuit.

The research method was based on split plot design. Two treatments were administered: the first consisted of three heat treatments: boiling, steaming, and baking; the second was substituting wheat flour with different proportions of modified potato flour, namely 10, 20, 30, and 40% respectively. If the calculated F value was greater than the interaction of the F value in the distribution table at the level of 5%, then Least Square design test would have been conducted. However, since there was no interaction, Duncan's multiple range test was carried out.

### Manufacturing Physically Modified Potato Flour

The first stage of this research was manufacturing physically modified potato flour using pre-heating. Potato tubers were cut into smaller size after cleaning, and then given heat treatment (boiling or steaming or baking). The potato tubers were then mashed into smaller particle and stored in the refrigerator with a temperature of 4°C for 24 hours. The potato was further dried at a temperature of 50°C until the weight became constant. It was later ground and sieved into modified potato flour.

### Manufacturing Biscuit Substituted Physically Modified Potato Flour

The biscuit was manufactured using a method proposed by Herudiyanto & Hudaya (2008). Physically modified potato flour was mixed with wheat flour at different proportions, namely 10%, 20%, 30%, 40% respectively; about 30% refined sugar (sucrose) was mixed and stirred

with 40% butter and 10% milk (based on total weight of composite flour). Later, composite flour and other ingredients were later stirred together to form a dough, then formed into the shape of biscuit and later baked at temperature of 160°C.

Chemical characteristics and sensory properties of biscuit were investigated. Analysis of chemical characteristics included moisture content, ash content, protein content, fat content and dietary fibre content. Sensory analysis was conducted using hedonic quality test for colour, taste and after taste with a scale of 1-5, where a value of 1 is very good, 2 is good, 3 is rather good, 4 is rather good, and 5 is very good.

## RESULTS AND DISCUSSIONS

### Characteristics of Physically Modified Potato Flour

Potato flour was modified physically using heat treatment. The heat treatments were boiling, steaming or baking. The characteristics of physically modified potato flour are shown in Table 2. The moisture content of modified potato flour is within the threshold levels of moisture content for wheat flour in Codex standard, not more than 15.5%. The flour which was baked had the lowest moisture content, 3.41%. This was due to the water being stripped away during baking and drying. This flour was expected to have the longest shelf life compared with the others. Ash content of modified potato flour ranged from 2.78 to 3.63 %. According to codex standard for flour, the limit for ash content depends on buyer preference. However, modified potato flour has less protein content, ranging between 1.04 and 1.11%. Thus, protein fortification in vital.

Table 2
*Characteristics of physically modified potato flour based on different methods of heat treatment*

| Characteristics of Modified Potato flour | Different methods of heat treatment | | |
|---|---|---|---|
| | Boiling | Steaming | Baking |
| Moisture content (%) | 8,87 | 8,56 | 3,41 |
| Ash content (%) | 2,78 | 3,54 | 3,63 |
| Protein content (%) | 1,04 | 1,07 | 1,11 |
| Water Solubility (%) | 11,41 | 12,79 | 13,77 |
| Water absorption capacity (%) | 139,90 | 134,95 | 135,90 |

Water Absorption Capacity (WAC) is the amount of water absorbed by the flour to achieve the desired consistency or optimal end result. The WAC of modified potato flour ranged from 134.95 to 139.90%, which means 134.95 to 139.90 lbs water is required for every 100 lbs of flour. According to Gahona, Rao, & Stanley, (2008), WAC will affect the final product attributes and the shelf life of baked products like biscuit. The water solubility of modified potato flour ranged between 11.41 and 13.77%. This was relatively higher than the solubility of cassava and sweet potato flour which ranged from 3.92 to 9. 37%. It was influenced by amylose and amylopectin characteristics (Kusumayanti, Handayani, & Santosa, 2015).

## Chemical Characteristics of Biscuit made for Physically Modified Potato Flour substitute

Moisture content

Results of analysis of variance showed that there was no association between the proportion of flour and heat treatment of modified potato flour in moisture content of biscuit. Test result of moisture content of biscuit made from physically modified potato flour is shown in Table 3.

Table 3
*Moisture content of biscuit made from physically modified potato flour substitute*

| Heat treatment of physically modified potato flour | Moisture content (%) |
|---|---|
| Boiling | 4.06[a] |
| Steaming | 3.99[a] |
| Baking | 4.02[a] |
| Substitution level of physically modified potato flour | Moisture content (%) |
| 10% | 4.00[a] |
| 20% | 4.04[a] |
| 30% | 4.02[a] |
| 40% | 4.04[a] |

*Description:* The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

According to Indonesian National Standard (2011), maximum moisture content of biscuit is 5%. Therefore, biscuit made from modified potato flour does meet quality standard. As it has a very low moisture content, it will have a high shelf life.

## Ash content

The result of analysis of variance showed that there was no association between the proportion of substitute flour and the different heat treatment in ash content of biscuit (see Table 4). Ash content is the mineral content in flour and is determined by measuring the amount of combustion residue flour on predetermined conditions. The flour's ash content varies and depends on many factors such as varieties of its raw materials (potato). Potato tubers contain little mineral, around 0.4%. (Burlingame, Mouille, & Charrondiere, 2009) Therefore, the ash content of modified potato flour is low.

Table 4
*Ash content of biscuit substituted physically modified potato flour*

| Heat treatment of physically modified potato flour | Ash content (%) |
|---|---|
| Boiling | 0.02[a] |
| Steaming | 0.02[a] |
| Baking | 0.02[a] |
| Substitution rate of physically modified potato flour | Ash content (%) |
| 10% | 0.02[a] |
| 20% | 0.02[a] |
| 30% | 0.02[a] |
| 40% | 0.02[a] |

*Description:* The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

**Protein content.** The results of analysis of variance showed that there was no association between the proportion of substituted flour and heat treatment of modified potato flour in protein content of biscuit (see Table 5). The Indonesian National Standard (2011) set minimal protein content of biscuit at 5%. The protein content of biscuit substituted with modified potato flour ranged between 9.71 and 10.09%.

Protein content of biscuit on various treatments remained unchanged. The different proportions of flour substitutes and different methods of flour modification did not affect the stability of the protein. The protein content was high enough, contributed by milk as one of the ingredients.

Table 5
*Protein content of biscuit substituted physically modified potato flour*

| Heat treatment of physically modified potato flour | Protein content (%) |
|---|---|
| Boiling | 10.09[a] |
| Steaming | 9.71[a] |
| Baking | 9.97[a] |
| Proportion of  modified potato flour | Protein content (%) |
| 10% | 9.93[a] |
| 20% | 9.95[a] |
| 30% | 9.90[a] |
| 40% | 9.90[a] |

*Description:* The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

**Fat content.** Result of analysis of variance showed that there was no interaction association between the proportion of substituted flour and different heat treatment on fat content of the biscuit (Table 6). The fat content ranged between 28.38 and 28.56%.

Table 6
*Fat content of biscuit made from modified potato flour*

| Heat treatment of physically modified potato flour | Fat content (%) |
|---|---|
| Boiling | 28.56[a] |
| Steaming | 28.51[a] |
| Baking | 28.38[a] |
| Proportion of physically modified potato flour | Fat content (%) |
| 10% | 28.43[a] |
| 20% | 28.41[a] |
| 30% | 28.55[a] |
| 40% | 28.55[a] |

*Description:* The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

Fat content of biscuit on various treatments remained unchanged. Despite difference in proportion of substituted flour and difference methods of treatment, the stability of fat was not affected. The source of fat wheat flour, modified potato flour and other ingredients such as milk, and butter.

**Dietary fibre content.** The result of analysis of variance showed that there was a significant difference between the proportion of substituted flour and different heat treatment of modified potato flour on dietary fibre content (see Table 7). Biscuit made with a proportion of modified potato flour by baking method has the highest dietary fibre content, 5.9%. It shows that baking can increase the dietary fibre content of flour. The increase in dietary fibre is due to the modified potato flour. Baking method causes a change in resistant starch (RS) from RS type 2 into RS type 3 as a result of a retrogradation process. RS type 3 is more resistant to digestive enzyme (Wulan et al., 2006).

Table 7
*Dietary fibre content of biscuit made from physically modified potato flour*

| Heat treatment of physically modified potato flour | Dietary fibre content (%) |
|---|---|
| Boiling | 3.76[a] |
| Steaming | 4.76[a] |
| Baking | 5.90[b] |
| Substitution rate of physically modified potato flour | Dietary fibre content (%) |
| 10% | 3.29[a] |
| 20% | 4.00[a] |
| 30% | 5.31[b] |
| 40% | 6.49[b] |

*Description:* The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

The higher the content of modified potato flour the higher dietary fibre of biscuit. A proportion of 30% and 40% shows significant differences in dietary fibre content (Table 7). The higher the content of modified potato flour, the more resistant the starch in the biscuit.

A food may be claimed as a source of dietary fibre if it contains 1.50-2.00 grams of fibre per serving. (Koen, Blaauw, & Wentzel-Viljoen, 2016) If we assume one serving is 35 grams, then 100 g of biscuit should contain at least 5.70 grams of fibre. Therefore, biscuits which are made from 40% modified potato flour can be claimed as a source of dietary fibre. In addition, based on the daily Dietary Recommended Allowance (RDA) of dietary fibre for women, 100 grams of biscuit made from 40% modified potato flour can supply 26% of daily fibre needs. According to RDA, the daily fibre requirement for adult women is 25 g per day (Koehler, Pareo-Tubbeh, Romero, Baumgartner, & Garry, 1997).

## Sensory Properties of Biscuit made from Substituted Modified Potato Flour

Result of analysis of variance showed that there was no association between the proportion of modified potato flour and different heat treatment in sensory properties (Table 8). Colour and taste of biscuit are important sensory attributes that affect the pleasure of eating. These attributes influence consumer choice based. The biscuit acceptable to consumers on the aspect of colour, taste and after taste with average score of panellist ranged between 2.54 and 3.75. There was no significant difference in the evaluation of colour and taste. These indicate that substitution of modified potato flour in biscuit and different heat methods of physically modified flour have no effect on sensory properties except the colour of the biscuit.

Table 8
*Effect of physically modified potato flour substitution on sensory properties of biscuit*

| Heat treatment of physically modified potato flour | Colour | Taste | After Taste |
|---|---|---|---|
| Boiling | 3.75[a] | 3.64[a] | 3.42[a] |
| Steaming | 3.71[a] | 3.61[a] | 3.41[a] |
| Baking | 1.91[b] | 2.54[a] | 2.63[a] |
| Substitution rate of physically modified potato flour | Colour | Taste | After Taste |
| 10% | 3.55[a] | 3.76[a] | 3.65[a] |
| 20% | 3.17[a] | 3.27[a] | 3.17[a] |
| 30% | 2.87[a] | 3.09[a] | 3.01[a] |
| 40% | 2.69[b] | 2.89[b] | 2.77[a] |

*Description:* The score was based on panellist. The average treatment marked with the same lowercase letters is not significantly different at the 5% significance level according to Duncan's multiple range test

Biscuits made from 40% modified potato flour that were baked had the lowest score. Thus, baking causes the colour of modified potato flour to turn brown due to enzymes. In addition, the process of caramelising sugar and flour in the dough witness a change in the colour of the biscuit to brownish yellow (Friedman, 1996). Therefore, the higher the content of modified potato flour the lower the colour score. However, proportion of the modified potato flour to the other types of flour and methods used had no significant effect on taste and after-taste of biscuit. This is inconsistent with Ashraf et al.'s findings (2012) that resistant starch has lower impact on the sensory properties of food.

## CONCLUSION

Biscuits made from modified potato flour is gaining popularity among consumers based on sensory assessment. The amount of modified potato flour and difference methods used to make biscuits had no significant effect on taste and after-taste of biscuit. Biscuits made with 40% of modified potato flour is a good source of dietary fibre (6.49%) and has a fat, protein, ash and moisture contents of 28.5%, 9.90 %, 0.02%, and 4.04% respectively.

## ACKNOWLEDGMENT

This study was supported by Universitas Pendidikan Indonesia (UPI) Research Grants which the authors gratefully acknowledge.

## REFERENCES

Akubor, P. I. (2003). Functional properties and performance of cowpea/ plantain/wheat flour blends in biscuit. *Plant Foods for Human Nutrition, 58*(3), 1–8.

Ashoush, I. S., & Gadallah, M. G. E. (2011). Utilization of mango peels and seed kernels powders as sources of phytochemicals in biscuit. *World Journal of Dairy and Food Sciences, 6*(1), 35–42.

Ashraf, S., Anjum, F. M., Nadeem, M., & Riaz, A. (2012). Functional & technological aspects of resistant starch. *Pakistan Journal of Food Sciences, 22*(2), 90–95.

Aziah, N., & Noor, M. (2012). Physicochemical and organoleptic properties of cookies incorporated with legume flour. *International Food Research Journal, 19*(4), 1539–1543.

Baljeet, S. Y., Ritika, B., & Roshan, L. Y. (2010). Studies on functional properties and incorporation of buckwheat flour for biscuit making. *Journal International Food Research, 17*, 1067–1075.

Boobier, W., Baker, J., & Davies, B. (2006). Development of a healthy biscuit: an alternative approach to biscuit manufacture. *Nutrition Journal, 7*, 1-7.

Burlingame, B., Mouille, B., & Charrondiere, R. (2009). Nutrients, bioactive non-nutrients and anti-nutrients in potatoes. *Journal of Food Composition and Analysis, 22*(6), 494-502.

Chen, L., Liu, R., Qin, C., Mph, Y. M., & Zhang, J. (2010). Short communication sources and intake of resistant starch in the Chinese diet. *Asia Pacific Journal Clinic and Nutrition, 19*, 274–282.

Friedman, M. (1996). Food browning and its prevention: An overview. *Journal of Agricultural and Food Chemistry, 44*(3), 631-653.

Gahona, E., Rao, G. V., & Stanley, P., (2008). E-Handbook: Water absorption. Retrieved from http://bakerpedia.com.

Gibson, G. R., & Williams, C. M. (2000). *Functional foods: concept to product.* Woodhead publishing limited.

Herudiyanto, M. S., & Hudaya, S. (2008). Teknologi pengolahan roti dan kue. *Widya Padjajaran, Bandung*.

Hosafci, P. (2016). Gluten-free fast becoming new industry standard in baked goods, with high fibre one to watch. Retrieved from http://euromonitor.com.

Indonesian National Standard (2011). SNI 2973: 2011 - Biskuit. Kementerian Perindustrian.

Koehler, K. M., Pareo-Tubbeh, S. L., Romero, L. J., Baumgartner, R. N., & Garry, P. J. (1997). Folate nutrition and older adults: Challenges and opportunities. *Journal of the American Dietetic Association, 97*(2), 167-173.

Koen, N., Blaauw, R., & Wentzel-Viljoen, E. (2016). Food and nutrition labelling: the past, present and the way forward. *South African Journal of Clinical Nutrition, 29*(1), 13-21.

Kusumayanti, H., Handayani, N. A., & Santosa, H. (2015). Swelling power and water solubility of cassava and sweet potatoes flour. *Procedia Environmental Sciences, 23*, 164–167.

Leszczynski, W. (2004). Resistant starch – classification, structure, production. *Polish Journal of Food and Nutrition Sciences, 13*(54), 37–50.

Sajilata, M. G., Singhal, R. S., & Kulkarni, P. R. (2006). Resistant Starch. *Comprehensive Reviews in Food Science and Food Safety, 5*, 1–17.

Serrem, C. A., de Kock, H. L. & Taylor, J. (2011). Nutritional quality, sensory quality and consumer acceptability of sorghum and bread wheat biscuits fortified with defatted soy flour. *International Journal of Food Science and Technology, 4*6(1), 74-83.

Wulan, S. N., Saparianti, E., Widjanarko, S. B., & Kurnaeni, N. (2006). Simple starch modification using physical, chemical and combined physical and chemical methods to produce pre-cooked flour rich in resistant starch made of corn, potato and cassava. *Jurnal Teknologi Pertanian, 7*(1), 1–9.